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Description

[0001] The invention concerns a method of metering out compressible fluids, especially blowing agents like N_2 or CO_2, whereby the blowing agent adds the material being conveyed to the user (extruder, RIM machine or dual-belt system) at high pressure, and the amount of blowing agent is regulated by a pressure-control valve, which can keep the pressure differential constant with a fixed restrictor.

[0002] The known methods of producing foamed plastics use blowing agents that come in the form of a gas under normal conditions and are added under high pressure to a plastic, mostly a thermally softened plastic mass, and are mixed homogeneously with it. When the mixture is finally put under normal pressure, the blowing agent causes the plastic to foam.

[0003] The molten plastic is conveyed into the extruder by a worm drive to an output nozzle. At a certain place on the extruder, the fluid blowing agent is added, which is mixed with the plastic on the way to the outlet nozzle. To keep the production quality unchanged in this method, the flowing blowing agent and plastic mass must remain constant and proportional to one another. Otherwise, the plastic extruded from the nozzle will foam very differently. Production defects and waste are the result, which would make the production process unprofitable.

[0004] The need to add a precisely metered stream of blowing agent to the plastic mass was met in the past by flow metering pumps. Since compressed inert gases are also increasingly being used as blowing agents, new metering devices must be used for them. Usually, such inert gases are metered by means of a control valve in the liquid or hypercritical phase. The control valve is supplied with constant precompression by means of a pressure reducer connected upstream. The back pressure of the control valve is due to the pressure of the mass of plastic melt. For example, if the pressure of the mass drops, the blowing agent must be restricted by the control valve. When the extruder is operating, the pressure fluctuations between the control valve range up to roughly 10 bar. These fluctuations in the pressure of the mass must be constantly offset by the control valve, which means the valve must have a certain minimum control range.

[0005] On an RIM machine (reaction-injection molding) or a dual-belt system, the blowing agent is metered in a precise mass ratio to the reaction mixture or an individual reaction component.

[0006] Gas-metering systems in which the amount of gas is controlled by a high-dynamic pressure control valve are known from the brochure "Maximator® G/D-Technik" from Schmick, Kranz & Co. GmbH, Zorge/Harz. This pressure-control valve can keep the pressure difference constant with a fixed restrictor,

which offsets pressure fluctuations of the user. Its advantage is that it can eliminate problems due to pressure fluctuations very quickly (as a rule < 1 sec). The disadvantage is that the operator here cannot preset the flow, but only set a certain pressure. This does not prevent drift.

[0007] A gas-metering method is known from DE 43 05 866 in which the pressure downstream from the control valve is kept constant by means of a pressure-control valve, and the amount of blowing agent is controlled directly in relation to the plastic mass being conveyed. This solution has the advantage that the operator can preset the flow, which is then controlled. The disadvantage is that the elimination of problems due to pressure fluctuations can only be controlled relatively slowly (> 10 s).

[0008] The problem of the invention is therefore to propose a method of metering compressible fluids in which the desired flow of blowing agent is reliably sent to the user all through the metering operation and so the quality of the final product stays the same over time.

[0009] The invention solves this problem by controlling the pressure difference as a function of the flow (x) of blowing agent.

[0010] The pressure difference is thus not kept constant by the restrictor, unlike the state of the art, but is determined by a flow controller.

[0011] In one preferred embodiment, the pressure is set by the pressure-control valve according to the relation $P_1 = P_2 + \Delta p$, whereby P_2 is the pressure downstream from the restrictor, Δp is proportional to the regulation ratio y of the flow controller and a function of (x-2), whereby x is the actual flow and w is the desired flow value. Δp is thus determined by a controller that works constantly with PI to find the deviation in actual flow from the predetermined desired value.

[0012] The invention has the following advantages: pressure jumps and fluctuations in working pressure P2 are offset quickly (< 1 sec), without affecting the flow regulator. Thus, the regulation ratio y of the flow controller remains constant. The controller is in no danger of control fluctuations. Because of this combination in the invention, control over the path is unusually fast with no tendency toward instability.

[0013] A screen, manual valve or control valve can be used as the restrictor. These restrictor organs have the following features:

<u>Screen</u>

[0014]

Advantage:	Fixed restriction, without drift, wrong setting not possible.
Disadvantage:	The working range of a screen is limited in terms of different flow quantities.

Manual valve:

[0015]

Advantage:	Variable as a restrictor in terms of different amounts of flow
Disadvantage:	There is drift over a longer period of time, wrong setting is possible.

Control valve

[0016]

Advantage:	Working range is large in terms of different amounts of flow. The restrictor valve is reproducible by defined drive.
Disadvantage:	Higher expense for control and valve.

[0017] In one preferred embodiment, one or two PI controllers are used, which are represented by a programmable memory control or by a process controller.

[0018] In another embodiment of the invention, the working pressure P_2 can be measured either directly in the line, or is determined from an existing process variable. On extruders, this can be done, for example, with the melt pressure and on RIM machines with the polyol or isocyanate pressure.

[0019] The invention is particularly suited for the production of plastic foams in extruders, RIM machines or dual-belt systems. But it is also suitable for foaming starches, for putting blowing agents into liquids like paint, milk or coffee, for subsequent atomization. Its is always suitable for use when there is a compressible fluid under high pressure that must be metered under high pressure into a carrier material with high precision in terms of amount.

[0020] Other advantages, features and embodiments of the invention, as well as a device for implementing the method, can be found in the following example of embodiment, which is explained in greater detail using the single figure.

[0021] The figure shows a flow control according to the invention, using an extruder as an example. The figure shows the extruder E, which is supplied with high-pressure gas through a line. The system provides a pressure-control valve V, the restrictor D, controllers RF for the flow and RP for the pressure, measurement devices P_1 and P_2 for the pressure downstream and upstream from the restrictor D, and the flow measurement device FT on either side in the line.

[0022] It works as follows: Upstream from the pressure-control valve V, which can be, for example, a fast-control (high-dynamic) 3/3-way valve, the gas pressure is approximately 400 bar of foaming gas. CO_2 and N_2 can be used here, for example. The initial variables given to the RF controller are the desired value w and the flow x. From the control deviation, the controller RF determines the regulation ratio y, for example, in the form of a signal 0-10 V. The pressure signal from P_2 in the form of 1-10 is added to this signal. This addition gives the desired value for the pressure controller RF. It converts the signal "Desired Value P_2" into Pressure P_1 with the high-dynamic pressure valve V. Typical set values are approx. 200-300 bar for P_1 and 150-250 bar for P_2. According to the invention, pressure P_1 is not set constantly now, but contains a correction term Δp, which is a function of the difference between the actual flow x and the desired flow w.